

STATEMENT OF WORK

for

PHASE B DEFINITION

of the

**GRAVITY RECOVERY AND CLIMATE EXPERIMENT
(GRACE) MISSION**

for the

**UNIVERSITY OF TEXAS
CENTER FOR SPACE RESEARCH**

(July 21, 1997)

1.0 INTRODUCTION

The GRACE Mission will produce a new model of the Earth's gravity field every 12 to 24 days with unprecedented accuracy for a period of five years. This measurement duration allows for the separation of the temporal and static gravity field components, providing both a high-accuracy static field and its time variations. The GRACE Mission will acquire the data for the gravity fields by flying two low altitude polar-orbiting satellites in a loosely controlled tandem formation. Variations in the Earth's gravity field will cause the distance between the two satellites to change. This variation will be measured with an effective precision of less than one micrometer/second in the line-of-sight range rate by a microwave link between the two satellites. Analysis of the data from GRACE will result in numerous advances in Earth sciences related to oceanography, hydrology, glaciology, atmospheric sciences and the solid Earth sciences.

In July 1996, the Office of Mission to Planet Earth (OMTPE) at NASA Headquarters released the first Announcement of Opportunity for the Earth System Science Pathfinder (ESSP) Program. The ESSP Program is intended to accomplish high quality, focused Earth System Science measurements utilizing innovative, streamlined management and implementation approaches designed to yield high value science. The GRACE Mission proposal was selected after a rigorous, two-phased selection process.

The GRACE Mission is a team effort being led by Dr. Byron Tapley of the University of Texas Center for Space Research (UTCSR). The Co-Principal Investigator is Dr. Christoph Reigber of the GeoForschungsZentrum (GFZ). The GRACE Mission Team consists of UTCSR, the Jet Propulsion Laboratory (JPL), Space Systems Loral (SS/L), NASA Langley Research Center (LaRC), Dornier SatellitenSysteme (DSS) and, under an International Memorandum of Understanding between NASA and DARA, the GeoForschungsZentrum (GFZ), and the Deutsche Forschungsanstalt für Luft und Raumfahrt (DLR).

This Statement of Work (SOW) defines the work to be performed during Phase B in order to define and establish detailed requirements for flight and ground segments and mission operations of the Gravity Recovery and Climate Experiment (GRACE) Mission.

2.0 PROGRAM MANAGEMENT

The ESSP missions are to be implemented under a "Principal Investigator Mode" (PI Mode) in order to reduce mission development times, costs and schedules and achieve NASA goals within the current budget constraints. In the PI Mode, the PI takes full responsibility for all aspects of the mission, including instrument and spacecraft definition, development, integration, and test; ground system operations, science operations, mission operations, and data acquisition and distribution with the intention of allowing the PI the maximum flexibility to conduct the investigation. The PI will establish

and lead a mission team, optimizing the specialized talents of the various participating organizations. The PI will have the responsibility and accountability to accomplish the mission within the program's cost and schedule constraints. The mission team will use their own processes, procedures and methods to the fullest extent practical, and also develop new ways of doing business where cost, schedule and technical improvements can be achieved. Periodic progress reporting will combine cost, schedule and technical status using the team's own internal management reviews to meet the Government's reporting requirements. The PI will submit an annual cost and obligation plan and submit monthly reports of actual costs and obligations. If either the PI or NASA determines that the mission cannot be completed within the agreed upon constraints, a termination review will be held. In the ESSP Program, the PI is accountable to NASA for Mission success and will be given full responsibility for all aspects of the Mission.

NASA HQ Code IY will provide support in the development of a Memorandum of Understanding (MOU) with international partners on the GRACE Mission. For all other aspects of the GRACE mission, NASA HQ has delegated program management responsibility for the GRACE mission to the ESSP Project Office at the Goddard Space Flight Center (GSFC). The GSFC ESSP Project Office will provide mission funding, contract administration and oversight for the GRACE Mission. To implement the GRACE mission, GSFC ESSP Project Office will provide funds directly to three members of the GRACE team - UTCSR, JPL and LaRC. Furthermore, the Project Office may provide mission unique support, only as may be requested by the PI in writing and agreed upon by the ESSP Project Manager. This support may be in the form of support personnel, equipment, parts/supplies, or facilities from NASA or other Government sources. To fund this support, a portion of the PI's Mission funds would be retained by the ESSP Project Resources Office, to be disbursed as directed by the PI.

The PI, Dr. Byron Tapley and the University of Texas Center for Space Research (UTCSR), shall take full responsibility for all aspects of the GRACE Mission from definition through mission operations and data distribution. It is understood for mission requirements outside the scope of NAS5-97213, the PI may effect changes through recommendations to the GSFC Mission Manager. The GRACE mission shall meet the requirements contained within the Gravity Recovery and Climate Experiment Mission Definition and Requirements Agreement (MDRA) [Contract Attachment D] and be consistent with the design, development and operations plan as presented in the GRACE Proposal dated December 10, 1996.

JPL will be funded directly from the ESSP Project Office, and will receive technical guidance from to Dr. Tapley for the GRACE mission. Specifically, technical direction by the GSFC ESSP Project Office will be provided to JPL in consultation with Dr. Byron Tapley of UTCSR. As defined in the International MOU being negotiated between NASA and DARA, German Mission Team members are under the direction of

Prof. Christoph Reigber, with Dr. Byron Tapley maintaining overall responsibility for their performance as well.

The NASA LaRC will be funded directly from the ESSP Project Office and will receive technical guidance from JPL and UTCSR for the GRACE mission. More specifically, the ESSP Project Office will provide technical direction to LaRC in consultation with JPL and UTCSR.

The Phase B Study for the GRACE Mission will culminate in a Mission Design and Cost Review (MDCR), which will serve as a Confirmation Review for proceeding to Phases C/D/E. This review is expected to consist of a Non-Advocate Review (NAR)-style programmatic review. Contingent upon successful completion of the MDCR and confirmation by NASA, the GSFC ESSP Project Office will execute contract options to proceed with Phases C/D/E. UTCSR and the GRACE Mission Team shall, with NASA approval, commence the initial design and development of the mission flight and ground segment under this contract immediately following the MDCR.

3.0 PROJECT MANAGEMENT

The PI shall have overall responsibility for the work specified by this contract. The PI shall designate a single individual as Project Manager (PM) at JPL, who shall be given the requisite responsibility and authority to manage and administer this effort. This individual shall be the focal point of contact for GSFC. The Project Manager shall ensure that all objectives are accomplished within schedule and cost constraints, and provide timely reporting of overall progress.

UTCSR shall provide sufficient oversight for JPL to establish, implement and maintain a management system which integrates management disciplines (scientific and technical), functions, and systems into an overall activity to achieve cost-effective planning, organizing, controlling, and reporting of the mission objectives.

UTCSR shall provide sufficient oversight to JPL to be the U.S. interface for matters of project management to DARA, GFZ and DLR. UTCSR shall also collaborate with JPL and the Co-PI in assuring that German-provided services and materials meet the technical and schedule constraints of the GRACE Mission.

1) Schedules

UTCSR shall provide sufficient oversight for JPL to establish, implement and maintain a scheduling management function which develops, monitors and maintains the master schedule and derivative detailed schedules for the GRACE Mission development activities. These schedules shall establish the interrelationships and time-phasing of activities and events essential for the timely and effective implementation of the program,

and shall identify critical paths and schedule slack. The initial master or level 1 schedule developed by JPL shall constitute the "baseline" schedule and shall come under configuration control consistent with the program configuration management procedures.

2) Monthly Progress Reports

UTCSR shall submit Monthly Progress Reports utilizing narrative text, graphs and/or schedules, which shall include but not necessarily be limited to:

- a) Summary Status - Summarize the current contract and schedule status. Identify any anticipated changes in scheduled milestones. Provide current status of all critical path items and report schedule slack. Provide current status of all mission critical technical resources (mass, power, etc.), including margins or reserves. Provide current status of mission cost reserves, including liens.
- b) Major Accomplishments - Summarize achieved accomplishments versus planned accomplishments for the previous month and delineate planned accomplishments for the next month.
- c) Current Problems - Present a "Top Ten" list of problems. State progress toward solving problems previously identified and discuss new problems that have been identified during the past month, including schedule for resolution. State whether action by, or assistance from, either mission team management or GSFC is required. Identify potential work around positions if a problem will have a significant impact on the on-time completion of the contract or on critical scheduled milestones.
- d) Problem Avoidance - Recommend action by either mission team management or GSFC which would assist in preventing major potential problems from developing.
- e) Risk Management Status Report - Update the list of the high risk items, discussing any risk mitigation actions which were implemented, and give a status of upcoming risk decision points.
- f) Facility Status Report - Discuss the status of facilities.

The Monthly Progress Report shall be submitted as three (3) hard copies and electronically to the ESSP Project Office at GSFC, with an accompanying teleconference or presentation. The location of any monthly presentations shall be determined by mutual consent of the UTCSR, JPL and the ESSP Project Office.

UTCSR, together with JPL, shall conduct quarterly status reviews with the ESSP Project Office. These reviews shall include up to date information on technical, cost, schedule and other programmatic issues. These reviews shall be conducted in person at either the ESSP Project Office or at a GRACE Mission Team member's facility.

3) Monthly and Quarterly Contractor Financial Management Reports (533M/533Q)

UTCSR shall submit monthly and quarterly 533M and 533Q financial management reports, or equivalent as described in NPG 9501.2B "NASA Contractor Financial Management Reporting" (April 1996). GRACE financial management reports shall be prepared according to the WBS and cost element structure contained in the GRACE proposal dated December 10, 1996, or as agreed upon by JPL, UTCSR and the ESSP Project Office. Financial management reporting shall be provided at the total cost/manpower level for WBS Level III and by cost element for WBS Level II. 533M and 533Q reporting shall be required for first-tier subcontracts that meet the reporting requirements set forth in NASA FAR Supplement Section 18-42.7201 (b) (1). UTCSR and JPL shall also provide contract funding profiles, as required, and explain variances between projected and actual costs that are reported on 533M and 533Q reports.

4) Reviews

UTCSR, together with JPL, shall provide the necessary resources to prepare technical and programmatic data packages for distribution and presentation at the Mission Design and Cost Review, to be conducted by a GSFC ESSP Project Office appointed review panel. Advance copies of the presentation package shall be submitted to the ESSP Project Office for review at least 10 working days prior to the formal presentation. All funding for long-lead part purchases made prior to official confirmation by the MDCR Review Panel, must be approved by the ESSP Project Office.

UTCSR, together with JPL, shall also conduct a Project Requirements Review, and shall establish a review team responsible for conducting the reviews and evaluating the status of the program. The team shall be comprised of individuals who have extensive experience with spaceflight programs and are independent of the GRACE Mission.

The ESSP Project Office shall be invited to attend all meetings and reviews conducted by the GRACE Mission Team.

5) Science Management

UTCSR shall collaborate with JPL in the definition of the GRACE instruments, defining operation of the PODAAC and the post-launch acquisition, processing, archiving and distribution of the GRACE science data. The Baseline and Minimum Science Mission requirements shall be documented in the GRACE Science and Mission Requirements Document.

4.0 SYSTEMS ENGINEERING

UTCSR shall provide sufficient oversight for JPL to establish a systems engineering capability which shall be responsible for integrating the technical efforts of the entire GRACE mission team to ensure that the performance objectives of the Mission are met with minimum risk. In addition, UTCSR, with JPL, shall:

- a) define and flow down the mission requirements for the GRACE Mission and incorporate these requirements into the GRACE Science and Mission Requirements Document;
- b) perform trade studies and status assessments to support the management decision making process;
- c) support the risk management process by identifying and characterizing risks and developing appropriate risk mitigation approaches;
- d) define all functional and physical interfaces, both internal and external to the Instrument and Spacecraft, and verify that they reflect the requirements for all GRACE systems elements (hardware, software, facilities, personnel and data);
- e) define all functional and physical interfaces for the ground system, including PODAAC;
- f) define all functional and physical interfaces between the Instrument, Spacecraft and/or Satellite and the ground support equipment (GSE);
- g) define all functional and physical interfaces between the instrument, spacecraft and satellite and the launch vehicle; and
- h) guide all necessary systems level engineering activities associated with specialty disciplines, which include, but are not limited to, reliability, contamination control, electromagnetic interference, space charging, and radiation effects.

5.0 PERFORMANCE ASSURANCE

UTCSR shall provide sufficient oversight for JPL to establish, implement and maintain a performance assurance program for both hardware and software development which is consistent with ISO 9000 requirements. This program shall be documented in a Mission Assurance Plan for the GRACE Mission, and shall apply to all work performed by JPL, its subcontractors and suppliers, and its team members. Effective management, control and implementation of the quality function is the prime objective of this task.

6.0 SAFETY

UTCSR shall provide sufficient oversight for JPL to establish, implement and maintain a system safety program that accomplishes the following:

- 1) Identifies and controls hazards to personnel, facilities, support equipment, and the flight system during all stages of mission development. The program shall address hazards in the flight hardware, associated software, ground support equipment, and support facilities.
- 2) Meets the system safety requirements stated in the applicable launch site safety regulation.
- 3) Meets the baseline industrial safety requirements of the institution, as well as any special contractually imposed mission unique obligations.

The safety program shall be documented in a Safety Plan for the GRACE Mission, and shall apply to all work performed by JPL, its subcontractors and suppliers, and its Mission Team members.

7.0 SCOPE OF WORK

In Phase B, the PI will delegate the requisite authority for project management, instrument prototyping and specification development for the spacecraft, instrument and ground system to the PM for the GRACE Mission. Tasks relating to these functions are included in a separate Statement of Work with JPL. Tasks to be performed solely or partly by UTCSR shall include but not be limited to:

- A) Develop with JPL and the GRACE Mission Team, a brief Project Implementation Plan for the Phase B effort. The plan should include a description of Phase B activities, schedules, roles and responsibilities of Mission Team members and a list of Phase B deliverables. The plan is due at the beginning of Phase B;

- B) Develop and support negotiations for all agreements between domestic, as well as international partners, including International Memorandums of Understanding (IMOU) and Project Memorandums of Understanding (PMOU);
- C) Develop, in collaboration with JPL, the GRACE Baseline and Minimum science requirements, to be included in the GRACE Science and Mission Requirements document;
- D) Develop, in collaboration with JPL, a GRACE mission software development plan;
- E) Collaborate with JPL to perform mission design trades and any technology demonstrations required during the definition phase;
- F) Together with JPL, prepare and submit an updated Phase C/D/E Project Implementation Plan and a Phase C/D/E Cost Plan, due at the MDCR, to include the following as a minimum:
- A revised Cost Plan with supporting data, in the same format and level of detail as required by the ESSP Announcement of Opportunity AO-96-MTPE-01, in real year dollars, which separately reflects costs for Phases C/D and E and includes a fully executed SF1411;
 - A Mission Development Plan for the design, development and operation of the mission flight and ground hardware and software, including launch, mission operations, and data processing and distribution;
 - A set of mission schedules with schedule slack and critical path(s) explicitly shown;
 - Management and decision-making roles and responsibilities of all GRACE Mission Team members;
 - Technical roles and responsibilities of all GRACE Mission Team members;
 - Finalized versions of all Team Agreements, International Memorandums of Understanding and Project Memorandums of Understanding for the GRACE Mission.
- G) Collaborate with JPL to develop a Risk Management system to be documented in the Phase C/D/E Project Implementation Plan, which includes a Risk Mitigation and Descoping Plan, meeting the following minimum requirements:

- Identification of the top ten risk items, with an associated risk mitigation plan for each, updated as necessary;
 - A list of pre-planned responses to potential mission risks that cannot be avoided by risk management measures;
- H) Collaborate with JPL to develop a plan for the prioritized descoping of the mission from the Baseline Science Mission to the Minimum Science Mission, including latest practical decision dates, in the event of a forecast of cost, schedule, or technical margin erosion. This should include a list of critical milestones which, if not met, will require the immediate attention of the GRACE Management Team.
- I) Develop with JPL, a set of recommended performance metrics for program evaluation by NASA and the Mission Team, including cost, schedule, and others as appropriate;
- J) Submit monthly progress and financial reports, as defined in section 3 of this document and in the contract;
- K) Develop an Education and Public Outreach Plan;
- L) Coordinate the definition of the GRACE Mission with JPL and NASA/GSFC by participating in programmatic and technical meetings as appropriate;
- M) In collaboration with JPL and the ESSP Project Office, develop and present material as necessary at the Mission Design and Cost Review (MDCR);
- N) In collaboration with JPL, prepare and submit a Phase B Final Report, which may consist of the MDCR presentation package and response to MDCR action items;
- O) UTCSR shall also provide sufficient oversight for JPL to assure that all launch interface requirements for the GRACE Mission are met.

8.0 COST ESTIMATES

The period of performance for the Phase B effort is from the effective contract date through December 31, 1998. The budget for the Phase B effort is .